RESPONSE UNDER 37 CFR 1.116
EXPEDITED PROCEDURE
EXAMINING GROUP 2834

PATENT
Attorney Docket No. 400906/SOGA

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

TANIGUCHI et al.

Application No. 09/697,678

Filed: October 27, 2000

For: ELASTIC WAVE GENERATOR

Art Unit: 2834

Examiner: M. Budd

AMENDMENTS TO CLAIMS MADE IN RESPONSE TO OFFICE ACTION DATED MAY 10, 2002

Amendments to existing claims:

26. (Amended) An elastic wave generator comprising:

an excitation coil;

a magnetostriction oscillator around which the excitation coil is wound and including laminated magnetostriction sheets having a metallic crystalline structure which exhibits positive strain characteristics in which length varies directionally upon magnetic excitation;

a spacer made of a non-magnetic material and located on a first end surface of said magnetostriction oscillator; and

an oscillator support having a first support surface shrink-fit and directly abutting said spacer, said first support surface intersecting a direction along which the length of said magnetostriction oscillator changes, and a second support surface ~~shrink-fir~~ shrink-fit and directly abutting a second end surface of said magnetostriction oscillator, said second support surface intersecting the direction along which the length of said magnetostriction oscillator changes, whereby said support applies a load to said magnetostriction oscillator so that the changes in the length of said magnetostriction oscillator due to the magnetic excitation of said excitation coil are supported by said first support surface, through said spacer, and said second support surface.

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PENDING CLAIMS AFTER AMENDMENTS
MADE IN RESPONSE TO OFFICE ACTION DATED MAY 10, 2002

1. An elastic wave generator comprising:

an excitation coil;

a magnetostriction oscillator around which the excitation coil is wound and including laminated magnetostriction sheets having a metallic crystalline structure which exhibits positive strain characteristics in which length varies directionally upon magnetic excitation; and

an oscillator support having a first support surface shrink-fit and directly abutting a first end surface of said magnetostriction oscillator, said first end surface intersecting a direction along which the length of said magnetostriction oscillator changes, and a second support surface shrink-fit and directly abutting a second end surface of said magnetostriction oscillator, said second end surface intersecting the direction along which the length of said magnetostriction oscillator changes, whereby said support applies a load to said magnetostriction oscillator so that the changes in the length of said magnetostriction oscillator due to the magnetic excitation of said excitation coil appearing at said first and second end surfaces are directly supported by said first and second support surfaces.

2. An elastic wave generator comprising:

an excitation coil;

a magnetostriction oscillator around which said excitation coil is wound and including laminated of magnetostriction sheets having a metallic crystalline structure which exhibits positive strain characteristics in which length varies directionally upon magnetic excitation;

a magnetic bias device having a magnetic path in common with said magnetostriction oscillator; and

an oscillator support having a first support surface shrink-fit and directly abutting a first end surface of said magnetostriction oscillator, said first end surface intersecting a direction along which the length of said magnetostriction oscillator changes, and a second support surface shrink-fit and directly abutting a second end surface of said magnetostriction oscillator, said second end surface intersecting the direction along which the length of said magnetostriction oscillator changes, whereby said support applies a load to said magnetostriction oscillator so that the changes in the length of said magnetostriction oscillator due to the magnetic excitation of said excitation coil appearing at said first and second end surfaces are directly supported by said first and second support surfaces.

3. The elastic wave generator as claimed in claim 1, wherein substantially all magnetostriction energy generated in said magnetostriction oscillator upon excitation of said excitation coil becomes an internal stress at shrink-fit interfaces between said first and second end surfaces of said magnetostriction oscillator and said first and second support surfaces of said oscillator support.

4. The elastic wave generator as claimed in claim 1, wherein an internal stress at a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and an internal stress at a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are initially set compression stresses required for said magnetostriction oscillator.

5. The elastic wave generator as claimed in claim 2, wherein an internal stress at a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and an internal stress at a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are stresses that provide, together with the magnetic

bias produced by said magnetic bias device, initially set compression stresses required for said magnetostriction oscillator.

6. The elastic wave generator as claimed in claim 1, wherein a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are provided by elevating temperature of said magnetostriction oscillator after said magnetostriction oscillator has been cooled in a cryogenic environment and has been installed between said first and second support surfaces of said oscillator support.

7. The elastic wave generator as claimed in claim 1, wherein a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are provided by lowering temperature of said oscillator support after said oscillator support has been heated to an elevated temperature and said magnetostriction oscillator has been installed between said first and second support surfaces of said oscillator support.

8. The elastic wave generator as claimed in claim 1, wherein said magnetostriction oscillator is made by bonding said magnetostriction sheets to each other with a hardenable material to form an integral structure of said laminated magnetostriction sheets.

9. The elastic wave generator as claimed in claim 1, wherein said oscillator support includes a pocket having a first wall surface which intersects the direction along which the length of said oscillator changes, said first wall surface being one of said first and second support surfaces of said oscillator support, said pocket having a second wall surface which opposes said first wall surface and intersects the direction along the length of said oscillator changes.

10. The elastic wave generator as claimed in claim 1, wherein said oscillator support and said magnetostriction support are materials having substantially equal coefficients of thermal expansion.

11. The elastic wave generator as claimed in claim 1, wherein

said magnetostriction oscillator is made by bonding said magnetostriction sheets to each other to form an integral structure of said laminated magnetostriction sheets;

said oscillator support and said magnetostriction support are materials having substantially equal coefficients of thermal expansion; and

an internal stress at a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and an internal stress at a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are initially set compression stresses required for said magnetostriction oscillator.

12. The elastic wave generator as claimed in claim 2, wherein

said magnetostriction oscillator is made by bonding said magnetostriction sheets to each other with a hardenable material to form an integral structure of said laminated magnetostriction sheets;

said oscillator support and said magnetostriction support are materials having substantially equal coefficients of thermal expansion; and

an internal stress at a first shrink-fit interface between said first end surface of said magnetostriction oscillator and said first support surface of said oscillator support and an internal stress at a second shrink-fit interface between said second end surface of said magnetostriction oscillator and said second support surface of said oscillator support are stresses that provide, together with the magnetic bias produced by said magnetic bias device, initially set compression stresses required for said magnetostriction oscillator.

14. The elastic wave generator as claimed in claim 1, including an excitation current supplying device for energizing the excitation coil, said excitation current supplying device having an output that can be controlled by a sensor output.

15. A mounted magnetostriction oscillator comprising:

an object to which an elastic wave is to be imparted; and

a magnetostriction oscillator mounted to the object, wherein said magnetostriction oscillator comprises an excitation coil wound around a stack of sheets of a metallic magnetostriction material bonded together with an electrically insulating bonding agent for generating an elastic wave in a direction parallel to said sheets with an excitation current flowing through said excitation coil, said magnetostriction oscillator having two parallel surfaces intersecting at right angles with an elastic wave radiation direction and spaced apart

from each other by a distance A at room temperature and a distance A1 at a temperature lower than room temperature, the object having a hole or a recess having two parallel wall surfaces intersecting at right angles with the elastic wave radiation direction and spaced apart from each other by a distance B at room temperature, where A>B>A1, and said magnetostriction oscillator is in direct contact with said wall surfaces and held in the hole or recess by having been shrink-fit against said wall surfaces by cooling the magnetostriction oscillator to below room temperature, inserting said magnetostriction oscillator in the hole or recess, and then returning said magnetostriction oscillator to room temperature, whereby said support applies a load to said magnetostriction oscillator so that the changes in the length of said magnetostriction oscillator due to the magnetic excitation of said excitation coil appearing at said first and second end surfaces are directly supported by said first and second support surfaces.

16. The mounted magnetostriction oscillator as claimed in claim 15, wherein said object is a non-magnetic body.

17. The mounted magnetostriction oscillator as claimed in claim 16, wherein said object is a tubular body.

18. The mounted magnetostriction oscillator as claimed in claim 17, wherein said sheets of a metallic magnetostriction material include a curved sheet having a radius of curvature substantially equal to that of said tubular body.

19. The mounted magnetostriction oscillator as claimed in claim 17, wherein the recess or hole comprises a circumferential groove extending over all of a circumference of said tubular body.

20. The mounted magnetostriction oscillator as claimed in claim 17, wherein said tubular body is a drill pipe for drilling.

26. An elastic wave generator comprising:

an excitation coil;

a magnetostriction oscillator around which the excitation coil is wound and including laminated magnetostriction sheets having a metallic crystalline structure which exhibits positive strain characteristics in which length varies directionally upon magnetic excitation;

a spacer made of a non-magnetic material and located on a first end surface of said magnetostriction oscillator; and

an oscillator support having a first support surface shrink-fit and directly abutting said spacer, said first support surface intersecting a direction along which the length of said magnetostriction oscillator changes, and a second support surface shrink-fit and directly abutting a second end surface of said magnetostriction oscillator, said second support surface intersecting the direction along which the length of said magnetostriction oscillator changes, whereby said support applies a load to said magnetostriction oscillator so that the changes in the length of said magnetostriction oscillator due to the magnetic excitation of said excitation coil are supported by said first support surface, through said spacer, and said second support surface.